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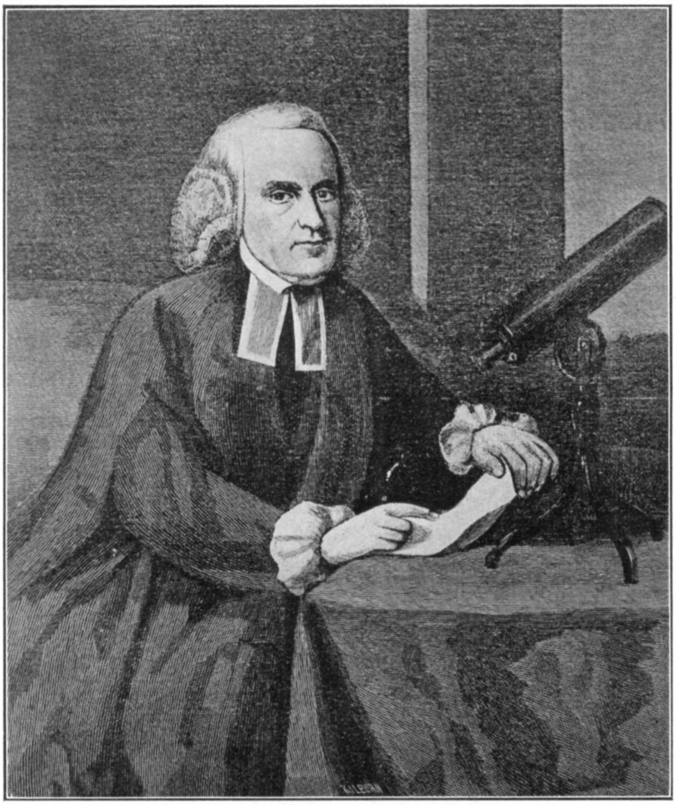

JOHN WINTHROP.

Reproduced by Mr. Leon Campbell, of Harvard College Observatory, from a steel engraving in Winsor's Memorial History of Boston.

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JOHN WINTHROP (1714-1779), AMERICA'S FIRST ASTRONOMER, AND THE SCIENCE OF HIS PERIOD.

By Frederick E. Brasch.

To many of the present generation of astronomers, the history of science, and more particularly the history of astronomy. in this country before 1840 (the year in which the American Association for the Advancement of Science was organized), possesses something of the spirit of the early renaissance of Europe. In all probability, their historical perspective is bounded by the year 1846, in which Harvard College Observatory was founded.

If one reviews the records of the past closely, there is no need to wonder that our knowledge is deficient in this respect, for the study of the history of scientific thought during the colonial period has practically been neglected. However, there are several very excellent treatises upon the individual sciences; namely, E. P. Merrill, History of American Geology[1]; Dr. E. F. Smith, Chemistry in America[2]; Dr. Florian Cajori, History of the Teaching of Mathematics in the United States[3]. In the history of astronomy, several astronomical writers[4] have made brief references to the colonial period. For a comprehensive survey of the whole field of American science George Brown Goode[5] (1851-1896) is practically our first historian of science in this country.

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[1] Smithsonian Report, 1904. U. S. Mus.

[2] "Chemistry in America," Appleton, 1914.

[3] Bureau of Education, Washington, 1890.

[4] Safford, Newcomb, Holden, Young and See.

[5] "History of Science in America." Nat. Mus. Report, 1897, Pt. II, Washington. 1901.

While it is true that the period of early settlement of community life had not the spirit, resources, and inclination for investigations in the phenomena of nature, yet the history of that most critical and interesting period of colonization contains many records of the attempts to advance science, especially astronomy. In one form or other astronomy seems to have been the favorite subject of abstract and practical thinking in the Colonies, primarily for the vain art of astrology and for almanac construction. There are evidences also that the "learned ministry" were assiduously engaged in computing eclipses, and in observing other celestial phenomena. In one most curious record[6] we find a Rev. Samuel Danford of Roxbury, New England, who published in 1665 "Astronomical Description of the Comet of 1664," with brief theological applications, and in the church records he has left various memoranda such as the following: "Anno 1652, 9th day, 10th month. There appeared a comet in ye heaven in Orion, which continued its course tow^{d} or zenith f^{r} space of a fortnight, vis till Mr. Cotton's death."

A good introduction to the spirit and progress in that age may be obtained by studying it in terms of the parallel period in Europe. Colonial science was born of European thought and nursed by English scholars, due to the fact that the colonists carried over with them the sciences and culture of the old world.

When Harvard College was founded in 1636, making Boston the earliest colonial intellectual center, the first century since the publication of the "De revolutionbus orbium celestium" by Copernicus, had not passed; Kepler had announced his three laws of celestial mechanics; Galileo had made his discoveries; but Newton was not born, and the Greenwich and Paris observatories had not come into existence, nor had the great academies of sciences in England, France, and Italy been incorporated.

In the American colonies, the intellectual life—and its contribution to the value and realism of scientific thought—was still firmly involved in the romantic and historical traditions of the land. The pre-colonial or puritanic epoch was clothed in the spirit of mysticism and the superstition of Europe, and not until the early 18th century do we find any marked advance towards empirical reasoning in scientific knowledge.

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[6] "Memorial History of Boston." 4, 490.

Science, however, did not rest long under the yoke of the theological speculations of that epoch, for it soon appeared as an integral part of the growing life of progress. This more progressive and liberal attitude toward the problems of science had its formation, not so much in the opposition of the old puritanic theology, as in the development of the economic life of the growing communities. The westward movement, the economic expansion, and the cultivation of the arts and sciences had a correlated interdependence as well as a parallel history in their development.

Naturally the first impulse of the growth of this character was felt in the local centers of learning. Therefore, Harvard College, founded as an institution for the Christian ministry, again, after a hundred years of struggle, began to take on fresh life; introduced new and more extended courses in science, and vitalized her methods of instruction. During this second period —beginning with 1736—the critical point in the history of science teaching was reached. All instruction in Latin, Greek, logic, metaphysics, mathematics, and natural philosophy was divided into groups, commonly known today as departments, and for the first time the last two groups were established as a separate and endowed professorship. This innovation in science instruction was liberally endowed by an English merchant-banker, Thomas Hollis, and was known as the Hollis Professorship of Mathematics and Natural Philosophy. The first occupant of this chair failed, and John Winthrop was appointed.

John Winthrop was born in Boston, December 19, 1714, of the fourth generation of the long line of Winthrops honored in history. Several of the Winthrops of colonial times were patrons of the sciences, but none employed such high talent so exclusively in this field of activity, nor attained so great esteem, as did the subject of this sketch. At present little is known of his early life, except that during his college career (1728-32) he was recognized as an exceptionally brilliant student. He immediately developed a great fondness for mathematics and astronomy, which later became his life work. Winthrop at the age of eighteen years was graduated from Harvard College in 1732 at the head of his class. For the next six years little seems to be known of him, and not until 1738,—when a vacancy was created in the Hollis Professorship of Mathematics and Natural Philosophy,—do we find our young scholar before the committee from the overseers of the college to be examined upon his proficiency in mathematics. Another committee was to examine Winthrop for any possible contamination of heresy and the status of his liberal ideas, which it was feared might prove too dangerous for Harvard at that period. However, this action was finally voted down. According to the custom of the day, his election was approved, and at the age of twenty-four years he was formally inaugurated and launched upon a successful career, extending over more than forty years of continuous service to his *alma mater*. He ·entered upon his work with zeal and activity, and with the fullest understanding of the large task before him.

As has been pointed out, the science of the colonial period was transplanted English science or thought, largely due to the fact that English methods and books of instruction prevailed; and also, the Royal Society acted as an authority and sponsor of the colonial scholarly attainments. But it will be shown that the work and influence of John Winthrop established for the first time America's independence in scientific development, and also gave to Harvard College her early prominence in scientific investigations. Thus, not alone did he lay the foundation of Harvard's supremacy in science, but earned the rank of America's first astronomer and scientist, thereby giving to his name a larger place in the history of American science.

Winthrop's influence was probably greater than that of any other man of culture thruout the Colonies. Both Franklin and Count Rumford owe much to him. The Royal Society early recognized his worth, as did also the astronomers-royal, Bliss and Maskelyne. There seems to be no record of any description showing whether he was in correspondence with his co-worker in a common field, David Rittenhouse of Philadelphia, his junior contemporary, altho both were elected members to the American Philosophical Society in the same year and were mutual friends of Benjamin Franklin.

Winthrop's European contemporaries were Newton (1727), Halley (1742), Jean Baily (1793), Delambre (1822), and La Place, Lavoisier, Herschel, Kant, and Leibniz. These later men were at the zenith of their powers. The new astronomy was just being developed. At this period Herschel was engaged upon his famous study of nebulæ and double-stars, Kant and La Place in the study of cosmogony,—the origin of the solar system. All these discoveries were as yet unknown to Winthrop.

Few men have been so catholic in their taste as Winthrop, so far at least as astronomy is concerned. He was an excellent mathematician, astronomer, meteorologist and something of a geologist, equally learned and original. In the fullest sense of the term, indeed, he was a natural philosopher.

While Winthrop was primarily a teacher, yet his temperament and training enabled him to utilize every possible opportunity at his disposal for the good of science and society. Not only was he regarded as the greatest mathematician[7] of his age on this side of the Atlantic, but he was also equally keen as an observer of natural phenomena; accurate, methodical, and skillful. The demand upon his time as a writer and lecturer during his early career was heavy.

The documents still extant are evidence conclusive of his simple literary style, which is clear, lucid, accurate, and above all attractive. He was greatly admired by his students and fellow citizens for his admirable personal qualities, for his calm and dignified attitude toward his work, and his ideals for service to the community.

Winthrop was stimulating and inspiring, both as a teacher and lecturer. Count Rumford, who as a lad of seventeen was a student under him, says: "I made sufficient progress in Natural Philosophy under that excellent and happy teacher."[8]

Winthrop's influence upon Rumford, no doubt, had much to do in holding the affection of this exiled scholar for his native country. Count Rumford's success enabled him to endow a professorship in science at Harvard College and a research fund in the American Academy of Arts and Sciences, as a token of his regard for the young republic.

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[7] Mass. Hist. Soc. Collections, 1st ser., **10**, 159.

[8] Ellis, "Life and Work of Count Rumford," **1**, 7.

The requirements and duties for a professor at Harvard at that period left little time for Winthrop's private work. However, he did, with much zeal, perform what astronomic work was possible, to his great credit. This can best be understood by studying his results in the following references. The modern laboratory was not known then, but Winthrop possessed apparatus which will illustrate the fundamental facts of natural philosophy then known. "For Astronomy"[9], he says, "we had before been supplied by Mr. Hollis with telescopes of different lengths, one of 24 feet; and a brass quadrant of two feet radius, carrying a telescope of a greater length, which formerly belonged to the celebrated Dr. Halley. We had also the most useful instrument for dialing; and for surveying, a brass semi-circle, with plain sights, and magnetic needles. Also a curious telescope, with a complete apparatus for taking the difference of leveling. From a number of gentlemen of the province the following additions were received: a fine reflecting telescope of different magnifying powers, and adapted to different observations. Microscopes of the several sorts now in use; Hadley quadrant, fitted in a new manner, a nice variation compass, and dipping needles with instruments for the several magnetical and electrical experiments,—all new and of excellent workmanship,—and all destroyed in the burning of Harvard Hall in 1764."

From the ruins of this disastrous fire an appeal was sent out over the land, which in time completely supplied new sets of apparatus and instruments for experimental philosophy. Besides philosophical apparatus, the following instruments for astronomical work were secured almost immediately: Glasses for telescopes, globes, an orrery, Hadley quadrant, a telescope twenty-eight feet in length of the Huyghens type, and a reflecting telescope of the Gregorian type. Most of these instruments, with an electrical machine given by Benjamin Franklin[10] to the college, are still to be seen in the

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[9] Quincy, "History of Harvard University," 2. 482-3.

[10] Cajori, "History of Physics," note, p. 127.

Jefferson Physical Laboratory and the Observatory of Harvard University.

Winthrop's first authentic astronomical observation was made in 1739 on spots upon the surface of the Sun. There seems to be no printed record of the observation of these phenomena. However, a manuscript copy is treasured in the Harvard College Library.[11]

We now come to Winthrop's first important astronomic work, which began with the observation of the transit of *Mercury* in 1740 (April 27th). This may be taken as the first real evidence of efforts to promote astronomical science in the colony. Rittenhouse did not begin his work until 1768.

The transit of *Mercury* over the Sun is not of such great astronomical importance as that of *Venus,* but serves as a means of ascertaining the planet's position, by which its orbit can be improved.

Winthrop had accepted as his authority Halley's (then the leading astronomer of Europe) tables and ephemeris of planetary motion, which were in use. He was advised that the former part of this transit would be visible in his horizon, and therefore resolved to observe it with an instrument he already possessed; namely, the 24-foot Huyghens telescope.

The qualitative results are probably not greatly different from our present knowledge of such transits, but it is in the methods of arriving at these results that the vast improvements have been made. Without the modern clocks, chronographs and electric circuit breaks,—also firmly mounted telescopes with all the accessories,—it is to be wondered that Winthrop accomplished his task at all. There is something inspiring in the spirit and zeal with which such pioneering work is sometimes accomplished. And Winthrop, with his splendid scientific characteristics and thoro knowledge and understanding of the theory of planetary motion, accomplished his task with such a marked degree of success, that his work was accepted by the Royal Society of London and published in full in the *Transactions.* It also received favorable mention in the Memoirs of the Royal Academy of Science at Paris. Winthrop was thanked by the Royal Society and asked to continue his communications, which immediately gave him high rank and finally led to his election as a fellow.

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[11] Private letters from Librarian W. C. Lane.

About this time our young astronomer made a number of minor observations upon such phenomena as lunar eclipses, meteors, and the determination of longitude, which was a question not fully settled as yet. He was also greatly interested in lightning and its relation to electricity.

In treating of the next problem of interest to Winthrop, we come upon a subject of more than common interest to us, an untouched field at this period of colonial progress, for it had not assumed any definite scientific status,—that is, the science of meteorology. Boston, the metropolis of New England, had a population in 1740 of something more than 25,000 inhabitants, with a surrounding farming country fairly prosperous, but as yet not depending upon accurate forecasting of the climatic changes. For forecasting, methods of analysis and instruments were required. The latter were rare and expensive. Moreover, the value and function of systematic weather prognostication had not been clearly understood, either for economic or industrial purposes.

Winthrop in 1742 began his series of meteorological observations, which continued upward of twenty years. It is not known whether he had in mind the true function and value of the data secured, but his fidelity to a certain idealism in science enabled him to make his observations with devotion. His early observations, 1742-59, were more or less inaccurate, due, no doubt, to faulty exposure and the imperfections of the instruments of that period; but his later series, 1759-63, were of more value.

The following is a description of the thermometer used by Winthrop in the first series. The original manuscript is in the possession of the American Academy of Arts and Sciences:[12]

"My thermometer was of Mr. Hawksbee's make, filled with spirit of wine. Ye scale is divided into 100 parts, beginning from a certain point above marked 0 and ye 100th degree falls just above ye bulb of ye thermometer. Ye freezing point is numbered 65°. Ye divisions are upward to 8° above zero. Ye observations are expressed in the degrees with their decimal parts.

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[12] Report of the International Meteorological Congress, Chicago, 1893, Pt. II, Washington, 1895.

"The instrument shows the highest temperature but not the lowest, for it goes into the bulb. How it was adjusted in London I know not, but it appears to me yt ye freezing point is marked considerable too high, for having plunged ye bulb into a vessel of snow I found yt ye spirit fell down to 76°.5 and then rested."

In 1759 Winthrop secured a Fahrenheit thermometer, placing it on the north side of the house, and, fortunately, comparative readings were made between the two thermometers, which gave an opportunity for comparing one scale with the other. These records were continued by him until 1763, and since then have been maintained by others with more or less completeness to our present day.

The year 1755 was a memorable one to the inhabitants of New England, due to the occurrence of an earthquake of some severity. The study of this phenomenon called forth Winthrop's best endeavors and revealed at the same time a large and broad-minded scientist. As a theorist, he probably was more modern than he has been given credit for. His observations, deductions, and the theory he advanced, besides the theological implications, were given in two lectures in the Harvard Chapel before the students and faculty. These lectures were printed at the general desire of the community, and remain as perhaps the earliest classic of American scientific literature.

The whole treatise shows an exceptionally comprehensive study. It is also a curious intermixture of analytical chemistry, mineralogy, geology, and astronomy.[13]

Winthrop is often called our first seismologist.[14] He was the first in this country to apply true inductive methods to observations of the earth-movement, and to advance the theory that the disturbances of the earth-crust were in the form of waves, and transmitted a pendulum-like motion to buildings and objects on the surface. He was the first to apply computation to the phenomena, consequently discovering the analogy between seismic motion and musical vibrations; he also discovered the principle that the quicker the motion the shorter the wave length of the disturbance. His ideas on the nature of heat were new to the science of geology, especially relating to the internal actions of volcanoes and earth-movements.

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[13] Full reprint in *Bulletin of Seismological Society of America*, **6**, 26-42, 1916.

[14] "National Biographies," (American), **7**, 165.

In view of the fact that his period lacked trained men to observe and study such phenomena, and also lacked the instruments and methods for recording their effects, it is surprising that his deductions were so complete and accurate.

Winthrop's theological views, liberally interspersed with his scientific observations, were not unduly incongruous with the general spirit of science or scientific belief. While he may have separated the idea that such phenomena of nature as earthquakes were not the direct expression of the wrath of God, he did not completely abandon the dualistic doctrine held so tenaciously by the puritan inhabitants of old New England. This was one of the objects of his public lectures, —primarily to alleviate the fears, superstition, and ignorance concerning the significance of such phenomena, since the credulous puritans were not yet entirely ready for purely scientific explanations of natural phenomena.

Winthrop's next public work was two lectures upon comets, and in particular on the return of the comet (1682) better known as Halley's comet, which he was fortunate to observe, since it was the first predicted return of a comet. This lecture was also read in the Chapel of Harvard College, 11th of April, 1759, as part of the regular and assigned duty of the Hollis professorship. Winthrop first observed this comet on April 3d, after it had passed perihelion, and, like similar celestial phenomena, had caused much anxiety and speculation as to its meaning.

In the first lecture his introduction to the subject of comets is descriptive, showing the relation and differences between comets, fixed stars and planets. This is followed by a history of their discovery with various theories concerning their origin and nature, especially during the preceding two hundred years.

His own observations and theories are, however, well worth considering, in their relation to astronomic thought and its bearing upon history. Winthrop has revealed himself as a mathematical and theoretical astronomer, but he has also proved his ability as a capable and practical observer. He computed the orbital elements of one of the comets under observation during this period; and his work upon the geometrical demonstrations, suggested by Newton, concerning the ascent of the tails of comets received laudable notices from the Royal Society.[15] This paper, the original of which was in Latin, entitled "Cogitata de Cometis"[16], was communicated to the Society by Dr. Franklin in 1766, May 6th, and read 1767, March 19th. It contains five problems, with dependent *scholia* and *corollaries*. In these he investigates the limits of attraction between the comets and the Sun, and the laws of motion and direction by which an elastic fluid or vapor arising from the head of a comet would be governed. He also deduces the masses and densities of comets from the observed breadth of the coma in the side next to the Sun. In this method, which he considers as entirely new to science, he infers that the density of the comet of 1665 was to the density of the Earth as 350 to 1; and that of the comet of 1682, as 5 to 11; and suggests an analogy in this respect, between comets and planets; that the densities are greater in proportion to their nearness to the Sun.

His explanation of the curved appearance of the tails of comets, which are occasionally manifested, contains this remark[17]—"that as no incurvature or deviation from the opposition to the Sun is perceived, but what may arise from the progressive motion of the head around the Sun, it appears probable that comets do not revolve on their axes."

In his second discourse before the college community April 18, 1759, he discussed the true theory of comets according to the work of Newton's "Principia," and also according to the laws formulated by Kepler, with the predictions of Halley. Like all his previous papers or lectures, Winthrop shows a profoundness of learning and authority. This is further evident from the mathematical computations connected with the solution of the orbital elements, and the origin of periodic comets, according to Halley.

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[15] Transactions, Royal Society, **12**, 405.

[16] Transactions, Royal Society, (old series), **57**, 132.

[17] "Lectures on Comets," p. XII, Professor Winthrop.

A more complete analysis of this colonial astronomer's knowledge of comets is not possible here, but further mention would be of interest and importance to the study of the history of astronomy in America.

As will be noted, Winthrop had no stated program by which to observe the "nightly heavens" regularly, as the modern astronomers have. He had no problems requiring long and continuous use of instruments and calculation for final solution. His was, essentially, the work of a pioneer laboring when time from his daily task would permit. Thus, again we find him in 1761 preparing, with foresight and diligence, plans to observe two events of great astronomical importance which took place in this country—the transits of *Venus,* in 1761 and 1769. Winthrop's keen sense of appreciation of the value of such opportunities was of vital significance in America's astronomical history. This is evident from the introduction to his first discourse[18] in 1769 on the use of the transit of *Venus.*

The first astronomical expedition in this country was that in which Harvard College and the Province of Massachusetts participated. That Harvard had a scholar so well trained, and disposed to undertake this scientific mission, speaks well for her eminence in science at that period. The ultimate success of this work depended upon the cooperation of many astronomers. European observatories, Greenwich and Paris, sent out five different observing parties to America. In Philadelphia, the American Philosophical Society authorized David Rittenhouse and a number of prominent gentlemen to make all preparation to observe this transit also.

A special act of the Massachusetts government granted the use of the Province sloop to convey Winthrop and two assistants, with instruments loaned by the College, to St. John's, Newfoundland. So, provided with a reflector having two wires, vertical and horizontal, and a clock, and all adjustments made, Winthrop says, "we waited for the critical hour, which proved favorable to our wishes." On June 6th the Sun rose at St. John's at 4^h 18^m with *Venus* upon its disk. He applied himself faithfully in observing the passage of the planet over the Sun, one assistant counting at the clock, the other recording the time and the observations made by Winthrop.

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[18] Two Lectures on the Parallax and Distance of the Sun as deducible from from the Transit of Venus, etc. March 1, 1769, Holden Chapel, Harvard College.

Without giving full details of the time of contacts and measurements of the passage of *Venus* across the Sun, it is sufficient to say that the results of the calculations gave the parallax of the Sun as $8''.25$. This value is apparently not the mean value of the parallax as it was derived from one set of observations based upon Halley's method; namely, the "method of duration," that is, observation of the contacts, and also of the position of the planet on the Sun. While Winthrop observed this transit very thoroly and made careful computations, yet his instruments and methods were naturally not such as to give results to be compared with those of Newcomb and others from the transits of 1878 and 1882. However, he later gathered all available observations, and from these determinations found the Sun's parallax, at its mean distance from the Earth, to be $8''.68$, which is comparable with the present accepted value. In the second transit of *Venus* (June 3, 1769), which again called forth important preparations both in Europe and the Colonies, similar observations were made by Winthrop in Cambridge, by West in Providence, and by Rittenhouse in Philadelphia.

The astronomer-royal, Dr. Maskelyne, had urged Winthrop to plan for observations in the Lake Superior region, where both the beginning and end were visible. But to his great disappointment, his health would not permit the long and rigorous journey. Consequently, Winthrop could only observe the first two contacts of this transit as the last two occurred at sunset (New England time). Again our colonial astronomer made a detailed study of all the observations available, both of this transit and of that of 1761; but the results exceeded the computed values of parallax given by him in his second lecture.

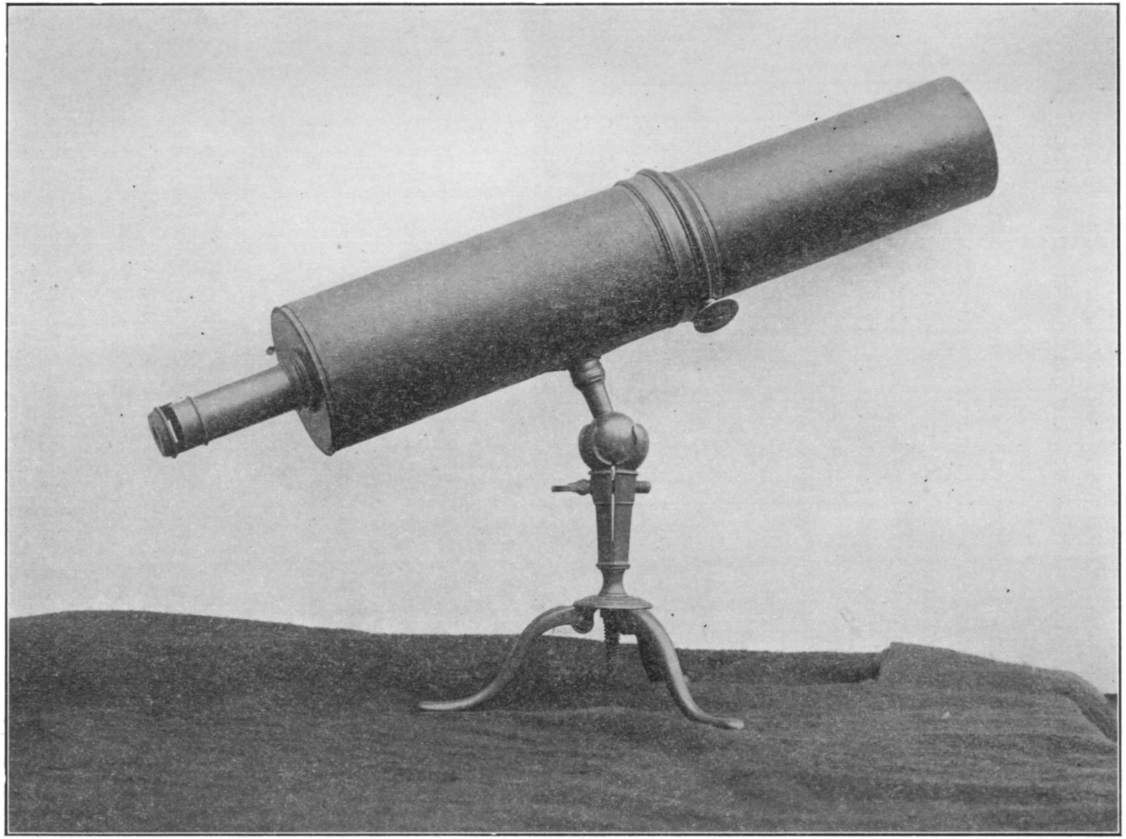
In order to obtain a clearer historical interpretation of this scholar's ideas and knowledge of the problems of astronomy, and those involved in transit observations, the following extracts of his first and second lectures upon the subject are given verbatim: "A transit of *Venus* over the Sun is the most uncommon and most important phenomenon that the whole compass of astronomy affords us. So uncommon is it, that it can never happen above twice in any century; in others but once; and in some centuries it cannot happen at all. And the importance of it is such as to supply us with a certain and complete solution of a very curious problem, which is inaccessible in any other way. On both accounts it well deserves a very particular attention."

"So extremely rare are these phenomena, and in fact till that which was observed in 1761, there never had been but one seen since the creation."

"This was in December of the year 1639, and it was seen by two persons only: Jeremiah Horrock, a young English astronomer of an admirable genius, who was the only person that predicted it, and a friend of his, William Crabtree. And when this of next June is passed the present race of mortals may take their leave of these transits, for there is not the least probability that anyone who sees this will see another."

"On account of their rarity alone they must afford an exquisite entertainment to an astronomical taste. But this is not all. There is another circumstance which strongly recommends them. They furnish the only adequate means of solving a most difficult problem,—that of determining the true distance of the Sun from the Earth. This has always been a principal object of astronomical inquiry. Without this we can never ascertain the true dimensions of the solar system and the several orbits of which it is composed, nor assign the magnitudes and densities of the Sun, the planets, and comets; nor of consequence attain a just idea of the grandeur of the works of God." . . .

"It will not be easy to give a distinct account of the several steps in the method of applying these phenomena to this purpose without the use of diagrams, which are not suitable to this place. I shall, notwithstanding, endeavor to convey to you as clear an idea as I can of the general methods, and in order to do it I shall trace things from their first principles."



WINTHROP'S TELESCOPE.
PRESERVED AT HARVARD COLLEGE ORSERVATORY.
Photographed by Mr. Leon Campbell with the permission of
Dr. E. C. Pickering, Director.

The remainder of the lecture is given up to a descriptive account of *Venus's* passage over the Sun and methods of observing, also the theory of parallax and geometrical demonstrations.

Winthrop early appreciated the function of exact time, and therefore during 1763 he communicated with Dr. Bliss, then astronomer-royal, regarding his observations of the transit of *Mercury* of 1743, with the express purpose of determining the longitude of Cambridge by comparing them with the European results[19]; and he gives it as his opinion that the longitude might thereby be determined with more exactness than by any observations that had been made use of for that purpose.

Solar eclipses were as rare celestial phenomena to Winthrop as to most others, but on the 5th of August, 1766, it is recorded[20] that he observed an eclipse of the Sun. He makes no reference to the nature of this eclipse; that is, whether it was partial, annular, or total. He gives only the time of beginning and ending. However, from other historical data, it does not seem to have been a total eclipse, for the first[21] recorded total eclipse of the Sun in America observed scientifically was that of June 16, 1806. Winthrop's object in observing this eclipse seems to have been to determine the difference of time between Greenwich and Cambridge, for the same eclipse was observed by Dr. Maskelyne, astronomer-royal, and a study was made of the differences shown by these observations.

That Winthrop attempted to make original discoveries in astronomy as early as his period, shows that he was something more than an observer working along set formulas and plans. We find that in the observation for the transit of *Venus* in 1761 he "viewed the Sun with great attention in the reflector, both on the 5th and 6th of June, in hopes to find a satellite of *Venus*[22], but in vain." There were several spots then on the Sun, but none that he saw could be a satellite.

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[19] See note, "Memoirs of the American Academy of Arts and Sciences, **1**, 57-8.

[20] "Memoirs American Academy of Arts and Sciences," **1**, 21.

[21] Grant, "History of Physical Astronomy," p. 367.

[22] *Philosophical Trans.*, abrid. ser., **12**, 157.

Like Rittenhouse, he also observed an apparent "duskishness" about the planet *Venus*[23] at the point of the first internal contact during a transit, but as the planet passed over the Sun he could not perceive it further.

Besides observing these principal phenomena, Winthrop occasionally observed the occultations of *Jupiter's* satellites, made frequent observations on the Sun's surface for spots, and also observed lunar eclipses, meteors and comets.

In 1769 Winthrop published an account in the Boston journals of the observations of the brilliant comet which appeared on September 1st. The remarkable feature of this comet was the length of its tail, which he measured to be 45 degrees.

Again in 1770, in June, a remarkable comet appeared and passed its perihelion point in August. This comet had no tail and was noted for its swiftness, for it described in one day an arc of more than 40 degrees. Winthrop ascribed this excessive motion to the fact of its approach to the Earth on that day to within one-fiftieth part of the Earth's distance from the Sun.[24] He observed this comet with care and the observations enabled him to calculate its orbital elements.

In conclusion it may be well to note that he made a number of observations on such miscellaneous phenomena as lightning, aberration of light and a study of variation of the magnetic needle. In the study of lightning he cooperated with Franklin regarding the electrical properties and the effect such properties have on "iron point," the term given to electrical conductors attached to buildings. He also defended Franklin's "iron points" against the attack and misunderstanding of the orthodox clergy, who asserted that they permitted electricity to come to the Earth to produce earthquakes.[25]

He displayed eloquence as a speaker, tact and dignity in arguing and defending scientific truth against the theologists of puritan New England, who were ever fearing theism would be overturned. His brilliant writings are an excellent type of colonial literature and should be preserved as a precious contribution to the foundation of the history of American science, and more particularly astronomy.

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[23] *Trans. Amer. Phil. Soc.*, **1**, 25.

[24] Oliver, "Lecture on Comets," p. XVI.

[25] White, "A History of the Warfare of Science and Theology, **1**, 366.

While it is true that neither Winthrop nor Rittenhouse established an observatory of any type, or laid a great foundation for an astronomical school, or made extraordinary discoveries and advances in celestial phenomena, yet what they did as pioneers with the highest possible motive, was to create a tradition which to this day has permeated pure science; namely, in giving to the philosophy of science an idealism which is so potent a factor of progress in our understanding of the laws of Nature.

The Royal Society elected him a Fellow in 1765, and the American Philosophical Society enrolled him as a member in 1768. From the University of Edinburgh in 1771 he received the honorary LL. D. degree; and his *alma mater* conferred upon him the same degree in 1773,—the first honorary degree of Doctor of Laws conferred by Harvard University.

Winthrop was honored as no man of his period had been. He was easily recognized as the most learned and capable of men, and this gave him power, influence and authority in the council with Washington, Adams and those who aided in the shaping of the future destiny of the new nation. His love of liberty and independence stamped him unquestionably as a loyal citizen of the new republic.

Winthrop was married twice, and one of his five sons, James, attained some degree of eminence as a scholar and scientist.

In Cambridge on the 3d of May, in 1779, at the age of 65 years, John Winthrop, scholar, scientist and astronomer, passed away in the fullness of his fame; and he lies buried with his ancestors in the old King's Chapel burying ground, Boston.

Stanford University, California.
May, 1916.